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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Paper No. 26

Application Number: 09/492,557
Filing Date: January 27, 2000
Appellant(s): ANTHONY, THOMAS C.

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GROUP 2800

Paul H. Horstmann
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 8 December 2003.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Invention

The summary of invention contained in the brief is correct.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

The rejection of claims 34-42 stand or fall together because appellant's brief indicates that they should, as agreed with by examiner.

(8) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(9) Prior Art of Record

US 5,748,524	Chen et al.	5-1998
US 5,956,267	Hurst et al.	9-1999

Introduction to the Theory of Ferromagnetism by **Aharoni**, Clarendon Press: Oxford, 1996, p. 16.

(10) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

2. Claims 34-36, 38, 40, and 41 stand rejected under 35 U.S.C. 102(b) as being anticipated by US 5,748,524 (**Chen** et al.) considered with the text Introduction to the Theory of Ferromagnetism by **Aharoni,** Clarendon Press: Oxford, 1996, p. 16.

Regarding claims 34, 40, and 41, **Chen** discloses a magnetic memory (Figs. 6 and 7) comprising a memory cell comprising a sense layer/reference layer **21/23**, **41/43**, tunnel barrier **22**, **42** (instant claim 40) and a stabilizing (i.e. keeper) structure **30**, **55** which is formed of a soft or hard ferromagnetic material (col. 4, lines 58-63; col. 6, lines 5-10) formed adjacent to the sense layer (instant claim 41) with an easy axis --in the case of the soft magnetic material-- or a magnetized axis --in the case of the hard magnetic material-- oriented perpendicular to the easy axis of the sense layer and accordingly parallel to the edge regions of the sense layer; a shape that provides flux closure: a path for magnetic flux transport between a pair of opposing edge regions of the sense layer (col. 4, lines 41-44); and prevents disruptions (e.g. demagnetization fields) to the magnetization state **11** in the sense layer. (See Figs. 5-8; columns 3-6.)

Exchange coupling between the keeper structure and the sense layer necessarily occurs because the end regions are pinned by the keeper structure. Note that "exchange" and "exchange energy" are defined in the text Introduction to the Theory of Ferromagnetism by **Aharoni,** Clarendon Press: Oxford, 1996, p. 16, to be the existence of a force for aligning the spins of unpaired electrons i.e. aligning the magnetic moments. Accordingly, the ferromagnetic coupling is necessarily an example of "exchange coupling" by definition of exchange and exchange energy.

Regarding claim 35, **Chen** shows that the flux closure path between the edge regions prevents overall magnetization in the sense layer from straying from parallel and antiparallel orientations with respect to the easy axis of the sense layer.

Regarding claim 36, the keeper structure **30, 55** has an easy axis which is substantially perpendicular to the easy axis of the sense layer, as noted above.

Regarding claim 38, the keeper structure **30, 55** is formed from a permeable ferromagnetic material (NiFe or NiFeCo; col. 2, lines 4-10). Note the instant specification at p. 11, 13-17 states that this is the material of the keeper structure.

3. Claims 34, 37 and 39 stand rejected under 35 U.S.C. 102(e) as being anticipated by **Hurst** et al. (US 5,956,267).

Hurst discloses an MRAM array wherein each memory cell includes the sense layer / tunnel layer / reference layer stack, **70**, (Fig. 8, column 6, lines 27-42); the stabilizing structure "keeper" (**30** in Figs 6-8; not labeled in the trench in Figs. 9-13; column 5, lines 27-47) formed of a magnetically permeable ferromagnetic material which (1) has a U-shape (Figs. 9-13) which runs along the word**line** and therefore along plural memory cells (Abstract); (2) has a shape and proximity to the sense layer that provides flux closure: a path for magnetic flux transport between a pair of opposing edge regions of each sense layer; (3) inherently prevents disruptions to the magnetization state in each sense layer by specifically "directing demagnetization fields away from the edge regions;" and (4) applies a magnetic field to a set of edge regions by exchange coupling, that is **perpendicularly oriented** to the easy axis of each sense layer **in the absence of an electric current flowing** through the wordline. (See especially Fig. 16 which

shows the magnetic flux **only while current is flowing** through the wordline; column 7, lines 6-15.)

As further evidence that the easy axis of the keeper structure in **Hurst** is along the length direction of the keeper structure and accordingly perpendicular to the easy axis of the sense layer, see Applicant's specification, page 7, 1st paragraph. This paragraph indicates that the magnetic field lines orient in the same manner as in **Hurst** when a current is flowing through the wordline (i.e. according to the right hand rule or around the wordline, just a shown in Fig. 16 of **Hurst**) and therefore perpendicular to the shown direction **in the absence of current**, just as in Applicant's disclosure. If the magnetic field in the keeper **120** aligns as shown in Fig. 16 of **Hurst**, "[u]pon application of current in the wordline **120**" (column 7, lines 9-10) it is clear that the alignment is **not** as shown in it the absence of the current, which means it behaves as in the instant application and would result in a "substantially perpendicular" orientation to that orientation while current is flowing through the word line.

See *In re Swinhart*, 169 USPQ 226,229 (CCPA 1971) (where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on) and *In re Fitzgerald*, 205 USPQ 594 (CCPA 1980) (the burden of proof can be shifted to the applicant to show that subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 USC 102 or obviousness under 35 USC 103).

Regarding claims 37 and 39, **Hurst** shows the keeper structure is formed in a U shape which encases the read/write conductors (i.e. the word line) (Figs. 13 and 16).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 34, 37, and 39 stand rejected under 35 U.S.C. 103(a) as being unpatentable over **Hurst** considered with **Chen**.

If it is thought that the structure in **Hurst** does not inherently provide the magnetization or easy axis of the stabilizing (keeper) structure to be substantially perpendicular to the easy axis of the sense layer, then this may be a difference.

Chen teaches the benefits of stabilizing the ends of the sense layer substantially perpendicular to the easy axis of the sense layer, by using either soft or hard ferromagnetic material which is ferromagnetically coupled, i.e. ferromagnetically exchange coupled to the ends of both the sense layer and the reference layer by virtue of direct contact therewith. (See Chen col. 4, lines 10-11, 41-44, and 58-63; col. 6, lines 5-10. Compare to Applicant's specification, page 8, line 26 to page 9, line 4 and page 9, lines 18-24.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use a soft or hard ferromagnetic material to stabilize the magnetization of the edge regions of the sense layer in **Hurst** in a direction perpendicular to the easy axis of the sense layer

and to use a hard ferromagnetic material as taught by **Chen** for the beneficial reasons indicated therein, because stabilized end regions improves the magnetic memory over one which does not have stabilized end regions, as taught in both **Hurst** and **Chen**.

Alternatively, the prior art of **Chen**, as explained above, discloses each of the claimed features except for indicating that the keeper structure is in a U shape which encases the read/write conductors (i.e. the word line).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to modify the structure of **Chen** to form the U-shape of **Hurst**, for the reasons indicated in **Hurst**, at least at col. 7, lines 6-15, to more effectively concentrate the magnetic field above the word line than could be obtained by a keeper structure not formed in a U shape and encasing the word line.

6. Claim 42 stands rejected under 35 U.S.C. 103(a) as being unpatentable over **Chen** in view of US 5,587,943 (**Torok** et al.).

The prior art of **Chen**, as explained above, discloses each of the claimed features except for indicating if the memory cells have square outer dimensions.

Torok shows that a typical magnetic memory cell has square outer dimensions as a result of the intersection between the wordline and bitline which is square. (See Figs. 9, 11, 12A, 12B, 13, and 14.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to form the **Chen** memory cell in a square shape as taught by **Torok** because **Torok** teaches that this is standard shape for a memory cell. Moreover, one of ordinary skill would be motivated to

use the square shape formed by the intersection between the wordline and bitline in order to form an array of memory cells on a single chip, as shown in **Torok**.

(11) Response to Argument

The Appeal Brief presents the argument, Issue I, beginning on p. 5,

> **"A. Chen does not disclose a keeper structure that provides a flux closure path between a pair of edge regions of a sense layer as claimed in claim 34."**
> "Appellant submits that Chen does not disclose a keeper structure that provides a flux closure path between the edge regions of a sense layer as claimed in claim 34. Instead, Chen discloses a pinning material 30 that consists of two physically separate structures - one structure disposed on each edge region of a magnetic layer 23 of a magnetic memory cell 20. (See Figs 5 and 6 of Chen). Appellant respectfully submits that the pinning material 30 disclosed by Chen cannot provide a flux closure path between edge regions of a sense layer as claimed in claim 34 because Figs 5 and 6 of Chen clearly show that the pinning material 30 consists of two physically separate structures that do not provide a path between the edge regions of the magnetic layer 23."

Examiner respectfully disagrees. The fact that the pinning structures, **30** or **55**, in Chen are separate entities in no manner diminishes their ability to provide a flux closure path between the edge regions of the sense layer of Chen. While it is acknowledged that the keeper structure **56** shown in Fig. 1a may provide **one specific flux closure path**, it is not the only flux closure path possible. Instant claim 34 only requires that the keeper structure "have a shape and proximity to the sense layer which provides a flux closure path --not limited to the one specifically shown in Fig. 1a.

The configuration shown in the Chen Figs. 5, 6, and 7 would, in fact, have some magnetic flux closure path **between** the ends of the sense layer/reference layer **21/23**, **41/43**. Magnetic flux and magnetic field of a magnetic material exists through space in all directions,

i.e. in all three dimensions, as is notoriously well known. See Dictionary of Electronics, pp. 218 and 334, [Appendix A] for verification. Although the magnetic field strength and flux density diminish with distance, they do not simply disappear. According, a flux closure path as well as a magnetic field necessarily exists between the ends of the sense layer in Chen --regardless of its form, direction, or strength. The Appeal Brief fails to provide any evidence to the contrary. Rather the Brief provides only speculation that the pinning structures in Chen cannot close the magnetic loops between the ends and that such loops would be confined to the end regions of **21/23** or **41/43** in Chen.

In this regard, The Brief argues,

> "The Examiner has cited col. 4, lines 41-44 of Chen in support of his assertion that the pinning material 30 provides a flux closure path between edge regions of a sense layer. (See pages 2-3, Office Action, 6-3-03). The section of Chen cited by the Examiner is as follows:
>
>> "Generally, it is desirable to pin magnetic end vectors 28 and 29 in an orientation substantially perpendicular to the length, or parallel to width W so as to reduce the end effects and at least partially close the magnetic loops. (Chen, col. 4, lines 41-44)."
>
> "The Examiner has stated with respect to this cited section of Chen that
>
>> 'Because the "magnetic loops" are the magnetic field lines -i.e. magnetic flux path- the magnetic flux path is closed.' (Pages 8, Office Action, 6-3-03).
>
> "Appellant respectfully submits that any magnetic loops in the magnetic layer 23 of Chen that are closed by the pinning material 30 are magnetic loops that are confined to the respective edge regions of the magnetic layer 23 and not magnetic flux between edge regions as claimed in claim 34 because the pinning material 30 of Chen actually consists of two physically separate structures that cannot carry magnetic flux between the edge regions."

Examiner agrees with this statement in the Brief only to the extent that an additional flux closure paths may occur at the ends. Examiner respectfully disagrees, however, that the closed paths are confined to the ends because the magnetic flux extends in all three dimensions of space. The Brief provides no evidence as to how the pinning structures of Chen somehow eliminate the naturally occurring phenomenon of the extent of a magnetic flux or field. Further in this regard, note that nowhere in Chen, is it stated that the closed magnetic loops are "confined to the ends" as presently alleged in the Brief.

In short, in the absence of claiming a specific flux closure path, not presently claimed, for the specific "keeper structure" shown in the drawings of the instant application, or providing evidence proving that a flux path cannot exist between the ends of the sense layer in Chen -- regardless of the form or strength of the flux closure path-- the Brief has failed to demonstrate that the instant claims distinguish over the prior art of Chen.

The Appeal Brief presents the argument regarding Issue I, in the last paragraph on p. 6,

> "**B. Chen does not disclose a keeper structure that applies magnetic fields to the edge regions of a sense layer as claimed in claim 34.**
> "Appellant submits that Chen does not disclose a keeper structure that applies magnetic fields to a pair of edge regions of a sense layer as claimed in claim 34. The keeper structure of claim 34 applies magnetic fields to a pair of edge regions of a sense layer while also providing a flux closure path between the edge regions of the sense layer. In contrast, pinning material 30 of Chen consists of separate pinning material structures (See Figs 5-6 and col. 4, lines 58-63 of Chen) that pin respective each edge regions of a magnetic layer 23 (Chen, col. 4, lines 48-52). As shown above, the pinning material 30 of Chen does not provide a flux closure path between edge regions as does a keeper structure as claimed in claim 34."

If the Brief is arguing that Chen does not teach a "sense layer," Examiner respectfully disagrees. First Chen --like the instant application-- discloses an MRAM. Chen explains the standard structure of a memory cell of an MRAM having a sense line and a word line stack (col. 1, lines 9-47) which are the magnetic layers **21**, **23** (Fig. 6) and **41**, **43** (Fig. 7), separate by a magnetic tunnel junction 22 (Fig. 6), 42 (Fig. 7). (See Chen, col. 3, lines 47-65 and col. 5, lines 3-17.) Second, the memory cell structure shown in Chen Figs. 6 and 7 is the same as that shown in Fig. 2 of the instant application. (If it is not apparent in the drawings of the instant application, the memory cell **40** shown in Fig. 1a and 1b is that memory cell shown in Fig. 2 made up of layers **50**, **52**, and **54**.) Accordingly, Chen teaches a sense layer.

If the Brief is arguing that Chen does not apply a magnetic field to the ends of sense layer, Examiner respectfully but emphatically disagrees. This is the entire purpose of the Chen invention. Chen applies the magnetic field with the pinning (or "keeper") structures **30** (Fig. 6) and **55** (Fig. 7). To suggest otherwise is to contradict the showing in Chen.

If the Brief is arguing that the pinning ("keeper") structures do not provide path flux closure, then this is merely a repeat of the argument discussed under the section entitled "A. ..." above. Examiner incorporates the arguments from above, herein in their entirety. In short, the Chen structures **30** and **55** inherently provide a flux closure path between the end regions of the sense line. Note that both of the magnetic layers **21**, **23** are pinned by the structure **30**, as stated by Chen in the paragraph bridging cols. 4-5.

In conclusion, it is noted that the "pinning" structure in Chen performs the same function as the "keeper structure" of the instant application. Chen states the **problem** of **un**-pinned or "**un**-kept" ends of a sense layer beginning at col. 1, line 32,

> "In a non-volatile memory another magnetic memory cell is used which basically includes a finite dimension element of a giant magnetoresistive (GMR) material, a **sense** line, and a **word** line. The MRAM employs the GMR effect for memory operations. Magnetic vectors in one or all of the layers of GMR material are switched very quickly from one direction to an opposite direction when a magnetic field is applied to the GMR material over a certain threshold. According to the direction of the magnetic vectors in the GMR material, states are stored, for example, one direction can be defined as a logic "0", and another direction can be defined as a logic "1". The GMR material maintains these states even without a magnetic field being applied. In this type of device a **sense** current is passed through the cell along the longitudinal axis to **read** the stored state." (Emphasis added.)

> "However, because **ends** of the layers of magnetic material **form a discontinuity in magnetization distribution**, very high fields and magnetic poles are formed at **the discontinuity or ends of the layers**. These **high fields force magnetic vectors adjacent the ends to align approximately parallel to the discontinuities or ends**. These **end effects cause the <u>resistance</u> and <u>switching characteristics</u> of the cell to vary in accordance with the detailed distribution of the magnetic vectors adjacent the ends**. This **variation in resistance and switching characteristics can be sufficient to cause problems in the reading or sensing of stored states in the cell**." (Emphasis added.)

> "Accordingly, it is highly desirable to provide layers of magnetic material with **<u>non-varying</u> magnetic end vectors** and memory cells which utilize these layers." (Emphasis added.)

As stated many times the pinning material **30**, **55** in Chen (or "keeper structure" in Appellant's terminology) provides the "**non**-varying magnetic end vectors," as pointed out throughout Chen. For example, Chen states at col. 4, lines 41-44,

> "Generally, it is desirable to pin magnetic end vectors 28 and 29 in an orientation substantially perpendicular to the length, or parallel to width W so as to reduce the end effect and at least partially **close the magnetic loops**." (Emphasis added.)

Similarly, the instant specification states (at page 6, lines 7-31) that the function of the "keeper structure" is

> "In one embodiment, the structure 56 serves as a keeper for the sense layer 50 magnetization and may be referred to as the keeper structure 56. The keeper structure 56 is a soft magnetic material that provides a mechanism for flux closure, **thereby preventing the formation of demagnetization fields in the edge regions** 157-158. The keeper structure 56 is a high permeability ferromagnetic film that is magnetized with an easy axis substantially perpendicular to the easy axis of the sense layer 50 of the magnetic memory cell 40. The proximity of the keeper structure 56 to the magnetic memory cell 40 causes any **demagnetization fields that would have been produced in the absence of the keeper structure 56 to be directed through the keeper structure 56**. This provides a path for flux that substantially eliminates demagnetizing fields from acting on the sense layer 50 in the magnetic memory cell 40. **This prevents the overall magnetization in the sense layer 50 of the magnetic memory cell 40 from straying from the desired parallel or antiparallel directions** [i.e. **switching characteristics**] with respect to the pinned reference layer 54 in the magnetic memory cell 40. The keeper structure 56 **stabilizes** the magnetic memory cell 40 **in that it provides a pair of stable and discernable high and low <u>resistance</u> states** for storing a data bit." (Emphasis added.)

In other words, both the Chen and instant keeper structures provide stability (i.e. pinning) to the end regions of the magnetic layers (sense line, word line) that would otherwise exist in the absence of the keeper structures. The structures in each of Chen and the instant application perform the **same** function of removing or at least reducing de-stabilizing or de-magnetizing magnetic fields inherently produced at the ends of the a magnetic layer, by providing a flux closure path between the end regions with the pinning or keeper structure. As presently claimed, there simply exists no distinction in the pinning structure of Chen and the keeper structure of the instant claims. And again, there exists no evidence of record that the keeper structure requires a U-shape to provide a flux closure path --especially in light of the statement in Chen that the magnetic loops are closed at the ends. By creating a loop, the poles are diminished, as stated in Chen.

Finally, compare the pinned end vectors of the Chen Figs. 5-8, with the pinned vectors shown in the instant application Figs. 1c, 3a, and 3b. The pinned vectors are shown to be the same in each of Chen and in the instant application.

This concludes the rebuttal of arguments presented under Issue I.

The Appeal Brief presents the argument, Issue II beginning on p. 7,

> **II: Claims 34, 37, and 39 are not anticipated by Hurst because Hurst does not disclose the limitations of claim 34.**
>
> "Appellant respectfully submits that claim 34, and claims 37 and 39 which depend from claim 34, are not anticipated by Hurst because Hurst does not disclose a magnetic memory cell that includes a keeper structure having a proximity to a sense layer of the magnetic memory cell that provides a flux closure path between a pair of edge regions of the sense layer as claimed in claim 34. Moreover, Hurst does not disclose a keeper structure that applies magnetic fields to the edge regions of the sense layer as claimed in claim 34. Furthermore, Hurst does not disclose a keeper structure that applies magnetic fields using exchange coupling to the edge regions of the sense layer as claimed in claim 34."

Examiner respectfully disagrees. A simple comparison of the keeper structures in Hurst (Abstract, Figs. 13 and 16) and in the instant application (Fig. 1a) show that they are of the same U-shape and same proximity to the sense layer of the magnetic memory cell. They are also formed by the same damascene method (Hurst, Figs. 9-13; instant application, Figs. 5a-5e). The specifications indicate that the keeper structures are made of the same materials (Hurst col. 5, lines 26-37; instant specification, p. 11, lines 11-20). The keeper structures perform the same function of pinning the end vectors of the sense layer (Hurst, col. 7, lines 32-34; instant specification Figs. 1c, 3a, 3b). Also as in the instant application, the keeper structure in Hurst is

recognized to perform the same **additional** function of **reducing the electrical current required to write the sense line** by concentrating the magnetic field at the sense layer during a write operation (Hurst, col. 6, line 59 to col. 7, line 31 as shown in Figs. 14-16 **during a write operation**; instant specification, p. 7, lines 1-15). Because a magnetic field strength above a certain threshold level will switch (i.e. write) the magnetic vector, concentrating the magnetic field reduces the current required to generate the electric field a write operation. This feature of the keeper structure is also recognized by Appellant in the **instant application**, at the location just noted, p. 7, lines 1-15), stating,

> "The keeper structure 56 **reduces the electrical current** level needed to write the magnetic memory cell 40 to a desired logic state. The keeper structure 56 is analogous to a single-turn electromagnet. **Electrical current flowing through the conductor 20 rotates the magnetization of the keeper structure 56 from its quiescent state along its length to a direction perpendicular to the direction of electrical current flow according to the right hand rule [<u>the equivalent as shown in Figs. 14-16 of Hurst</u>]**. This creates a magnetic field along the easy axis of the sense layer 50 in the magnetic memory cell 40 which is useful for rotating the magnetization in the sense layer 50 to either the parallel or antiparallel state with respect to the pinned reference layer 54 of the magnetic memory cell 40." (Emphasis added.)

Accordingly, Examiner respectfully submits it is unclear as to how the Brief can present a plausible argument that the keeper structure in Hurst somehow fails to perform the same functions as that in the instant application, in light of the evidence of record showing, in fact, that the structure in Hurst performs the same two functions presently indicated in the instant specification for the keeper structure to perform. Even the same terminology is used: "keeper structure."

The Appeal Brief continues regarding Issue II, on p. 7,

> **"A. Hurst does not disclose a keeper structure having a proximity to a sense layer that provides a flux closure path between a pair of edge regions of the sense layer as claimed in claim 34."**
>
> "Appellant submits that Hurst does not disclose a keeper structure that provides a flux closure path between the edge regions of a sense layer as claimed in claim 34. Instead, Hurst discloses a keeper that concentrates flux generated in the word line onto a bit region. (Hurst, col. 6, line 65 through col. 7, line 15). For example, Hurst discloses a magnetic field keeper 122 that surrounds a word line 120 (Fig. 16 of Hurst) and states that
>
>> 'By providing a magnetic field keeper on the side walls 126a and 126b, the magnetic field 130 is even more effectively concentrated above the word line 120, thereby further increasing the magnetic field 130 at a bit region 132.' (Hurst, col. 7, lines 10-14).

As just noted above in the excerpt from the instant specification at p. 7, lines 1-15, **Appellant recognizes that the instant keeper structure performs this very same function that the Hurst keeper structure performs**. Accordingly Appellant's argument contradicts his own specification. In other words, Appellant cannot properly argue that the "flux concentration" feature in Hurst distinguishes from the instant keeper structure, when the instant keeper structure is admitted --in the instant specification-- to perform the same function as that in Hurst.

The Brief continues,

> "Moreover, the keeper of Hurst does not have a proximity to a sense layer that provides a flux closure path between edge regions of the sense layer as claimed in claim 34. Instead, the keeper of Hurst is spaced a distance away from a bit region of a magnetic memory. For example, Fig. 16 of Hurst shows a magnetic field keeper 120 that is spaced a distance away from a bit region 132 and that does not overlap the edge regions of the bit region 132 in a manner that would provide a flux closure path between the edge regions as claimed in claim 34. Similarly, Fig. 13 of Hurst shows a U-shaped keeper that is spaced a distance away

> from a bit region by an intervening dielectric layer and that does not overlap the edge regions of the bit region.[3]"

The argument that the insulating layer in Hurst prevents flux closure is factually in error. Hurst very clearly shows in Figs. 14-16 that the magnetic field lines --during a write operation-- penetrate through the insulating layer. In other words, direct contact is not required for a flux closure path to exist, as is notoriously well known to one of ordinary skill --just as the magnetic field penetrates through a sheet of cardboard to align iron filings along the field lines generated by the magnetic on the other side. Moreover, there exists no evidence of record that the proximity in Hurst is insufficient to provide a flux closure path --especially in light of the teachings in Hurst. Additionally, it is noted that **the instant specification requires <u>no</u> direct contact between the sense layer of the memory cell and the keeper structure**. The instant specification discusses the formation of the keeper structure on p. 11, as shown in instant Figs. 5a-5e. Immediately following on p. 12, first paragraph, the instant specification discusses the formation of the memory cell on the keeper structure. Note that --before the deposition of the sense layer-- seed layers, a reference layer, and an **insulating aluminum oxide** tunnel barrier layer are deposited. **Clearly, then Appellant recognizes that the magnetic flux closure path operates through other material layers --including insulating layers**; otherwise, the instant keeper structure would not work. The instant specification also provides examples in Fig. 6 wherein the there is a variable distance between the keeper structure 56 and the memory cells 40, wherein the distance is generated by a layer 20. Again, no direct contact is required for the keeper structure to perform its operation. For this reason, evidence is required to show the Hurst keeper structure does not somehow provide a flux closure path, in light of the evidence of record

that it does (Hurst, for example at col. 7, lines 32-34). No such evidence exists. Instead, the Brief merely provides allegations.

The Brief argues that, in the Hurst Fig. 16, there is no overlap between the ends of the keeper structure and the sense layer. This argument is factually in error. The overlap is shown in Fig. 13 of Hurst. Fig. 16 merely shows where the magnetic field is concentrated in the **portion** of the sense layer of the memory cell of Fig. 13 --during a read or write operation (i.e. with current flowing through the conductor into the page, as stated in Hurst).

Regarding the footnote labeled "3" at the bottom of p. 8 of the Brief. Examiner notes that the layer **30** shown in Fig. 4 of Hurst very clearly points out that the magnetic layer **30** forming the keeper structure is delineated by a diagonal crosshatch wherein the diagonals of the crosshatch move upward from left to right. The magnetic material **30** has barrier layers **36, 38** around it to prevent diffusion of the magnetic material **30** into the dielectric layer **10** --the same problem that will necessarily occur to the structure of the instant application in the absence of such barrier films. The same crosshatch is shown in the trench structures of Figs. 12, 13, 15, and 16 which very clearly point out the keeper structure, by virtue of the same pattern and layering as in labeled Fig. 4. Examiner respectfully submits that Hurst sufficiently labels the features by the patterns used therein. For convenience, Examiner has labeled Fig. 13.

The Brief continues on p. 8,

> **"B. Hurst does not disclose a keeper structure that applies magnetic fields to the edge regions of a sense layer as claimed in claim 34."**
>
> "Appellant submits that Hurst does not disclose a keeper structure that applies magnetic fields to a pair of edge regions of a sense layer as claimed in claim 34. Instead, Hurst discloses a keeper that concentrates flux generated in a word line onto a bit region. (Hurst, col. 6, line 65 through col. 7, line 15)."

As already addressed above, this argument contradicts the facts of record, since the instant keeper structure is admitted in the instant specification to perform the exact same function.

The Brief continues,

> "The Examiner on page 9 of the Office Action mailed 6-3-03 has cited col. 7, lines 32-47 of Hurst in support of his assertion that Hurst discloses a keeper structure that applies magnetic fields to the edge regions of a sense layer. The cited section of Hurst includes the following
>
> > 'it is contemplated that a reset line of a magnetic field sensor device may include the above-described magnetic field keeper to increase the magnetic field produced by the reset line at the magnetic material of the sensor device.'
>
> (Hurst, col. 7, lines 43-47) (emphasis added)."
>
> "Appellant respectfully submits that a keeper that applies a magnetic field to reset the magnetic material of a magnetic field sensor device as taught by Hurst does not anticipate a keeper that applies magnetic fields to the edge regions of the sense layer of a magnetic memory cell as claimed in claim 34 because the keeper of Hurst acts as a flux concentrator. (Hurst, col. 6, line 65 through col. 7, line 15). It is submitted that any attempt to use the keeper of Hurst to apply magnetic fields to the edge regions of a sense layer in a magnetic memory cell would, for example, wipe out any data stored in the sense layer of the magnetic memory cell."

As noted several times above, the keeper structure **56** of the instant specification is also a flux concentrator --**during a write operation only, but NOT during times when a write operation in NOT being performed**-- as indicated in Hurst (col. 6, line 59 to col. 7, line 31) and in the instant specification (p. 7, lines 1-27). The Brief is factually in error suggesting that magnetic flux concentration always occurs. This is false by Appellant's own admissions in the instant

specification and by the statements in Hurst. Flux concentration only occurs **during the writing operation**. Just as in a "reset operation" of a magnetic sensor, as indicated in Hurst, which is like a write operation in a memory cell to change or reset the edge domains.

The edge regions are pinned by the keeper structure of the MRAM just as in the sensor, because Hurst indicates that the keeper structure of Fig. 13 can be used as it is in the MRAM. Accordingly, the MRAM configured as the sensor would have the edge regions pinned. More importantly, there exists no evidence of record that, given the same functions, structure, and materials of the keeper structures in Hurst and in the instant application, the Hurst keeper structure would fail to perform the same operation of pinning the end regions.

Finally regarding the final sentence, from the excerpt from the Brief above, Examiner respectfully submits that the Brief is factually in error regarding the keeper structure of Hurst erasing data as a matter of course. Such **only occurs during a write operation**, intentionally as desired. Hurst shows the structure applying such fields and writes data to the sense layer of the memory cell of Fig. 13. Hurst makes no indication that data is inadvertently erased by the keeper structure. Making such an argument amounts to Appellant's argument that the *instant* keeper structure does not work. Because the structure, function, and materials are the same in Hurst as in the instant application, the structures must perform the same function. Moreover, there exists nothing but allegation in the Brief that such wiping out of data would occur in stark contrast to the evidence in Hurst that it does not.

On p. 9, the Brief argues, under the section entitled "C. **Hurst does not disclose a keeper structure that applies magnetic fields using exchange coupling to the edge regions of**

a sense layer as claimed in claim 34" that exchange coupling does not exists. As support, the Brief argues that the basic reference on ferromagnetism by Aharoni fails to use the word "coupling." Examiner believes that the reference of Aharoni explains exchange coupling quite clearly to those of ordinary skill in the art. For the benefit of Appellant, Examiner adds only the definition of "coupling." The Dictionary of Electronics defines "coupling," (at least in terms of in terms of electric circuits) as the **exchange of energy** from one circuit to another. (See Dictionary of Electronics, p. 105 in Appendix B.) As an example, a transformer is given. As is well known, a transformer is a pair of inductors (e.g. magnetic or electromagnetic coils) in proximity but not touching. The energy is transferred through the medium between the inductors, by **coupling**. Accordingly, as stated in Aharoni when the atomic spins of the electrons interact with each other --through the medium of space-- to force the others to align in the same direction, this exchange of energy to force alignment is, in fact, coupling --just as is occurring in the keeper structure of Hurst and in the pinning structure of Chen. Chen explicitly uses the term "coupling." It is exchange coupling for the reasons already of record as stated in the rejection of the claims, as repeated above.

Appellant bears the burden of proof to show that exchange coupling is not occurring. (See MPEP 2112.) The Brief fails to provide evidence in this regard and therefore fails to overcome the inherency argument. Given that the materials, structures, and functions of the keeper structure in Hurst and in the instant specification are the same, evidence is especially required. One of ordinary skill would expect the same structure to perform the same function.

Additionally in this regard, it is noted that MPEP 2145 states that "argument does not replace evidence where evidence is necessary." (See also MPEP 2106.02.)

The Brief then continues regarding the exchange coupling on p. 10,

> "Appellant's Specification provides illustrations of a keeper structure that is exchange coupled to a sense layer as claimed in claim 34 and a keeper structure that is not exchange coupled to a sense layer. For example, Fig. 1a of Appellant's Specification shows a keeper structure 56 exchange coupled to a pair of edge regions 157 and 158 and Appellant's Specification states that
>
> > 'The sense layer 50 is directly exchange coupled to the keeper structure 56 at the edge regions 157 and 158. The sense layer 50 is influenced by the magnitude and direction of the magnetic anisotropy of the keeper structure 56.'
>
> (Page 10 of Appellant's Specification)
>
> and provides an alternative to exchange coupling by stating that
>
> > 'Alternatively, the magnetic memory cell 40 is flipped over so that the reference layer 54 is adjacent to the keeper structure 56. The sense layer 50 is not exchange coupled to the keeper structure 56 but is influenced by the proximity of the permeable keeper structure 56 and no orthogonal field is generated in the edge regions 157-158.'
>
> (Page 10 of Appellant's Specification).
>
> "In this alternative configuration in which the keeper structure 56 is not exchange, coupled to the sense layer 50 but is instead separated from the sense layer 50 by a reference layer 54 is similar to the spacing between a keeper and a bit region taught by Hurst. Therefore, Appellant submits that Hurst does not disclose a keeper structure that applies magnetic fields using exchange coupling to a pair of edge regions of a sense layer as claimed in claim 34 because the keeper of Hurst is not coupled to a bit region but is instead separated from a bit region by an intervening dielectric '.layer. (See the bit region 70 and dielectric layer 60 in Figs. 7-8 and analogous structures in Fig. 13 of Hurst)."

While Examiner acknowledges that exchange coupling does not occur with the sense layer in this specific embodiment of the instant application, this is not evidence that the exchange coupling does not occur in the structure of Hurst.

Most importantly, **the admissions in the instant specification contradict the Brief's argument,** regarding exchange coupling not occurring in the Hurst device due to the presence of the insulating layer **60** shown in Fig. 13 of Hurst. As noted above, in the embodiment in which the instant specification states exchange coupling *does* occur, i.e. that embodiment shown in Figs. 1a, 1c, 5a-5e, as discussed in the instant specification on pp. 11 and 12, the **sense** layer is **not** in direct contact with the keeper structure, but is instead separated from the keeper structure 56 by **several seed layers, the reference layer**, and the **<u>insulating</u> aluminum oxide tunnel barrier**. **Yet exchange coupling is still stated to occur by Appellant**. (See p. 11 for the formation of the keeper structure as shown in Figs. 5a-5e and p. 12, first paragraph, for the order of the layers of the memory cell on top of the keeper structure of Figs. 5a-5e.) Accordingly, The Brief cannot properly argue that exchange coupling does not occur in Hurst because of the presence of an intervening insulating layer while the instant specification specifically indicates that exchange coupling does, in fact, occur through an insulating layer of aluminum oxide, as well as through several other layers.

This concludes the rebuttal of arguments presented under Issue II.

The Brief argues Issue III beginning on p. 11 of the Brief stating,

> **"III: Claims 34, 37, and 39 are not obvious in view of Hurst and Chen because Hurst and Chen do not disclose or suggest the limitations of claim 34."**

The introductory remarks and section A do not provide any additional argument but merely repeat statements previously made in the Brief. On p. 12, the Brief argues that there exists no motivation to combine the reference while providing absolutely no reference to the motivational statement provided in the Office action. For at least this reason, the Brief's arguments are not persuasive. First, as stated in the rejection above,

> "If it is thought that the structure in **Hurst** does not **inherently** provide the magnetization, or easy axis of the stabilizing (keeper) structure, to be substantially perpendicular to the easy axis of the sense layer, then this may be a difference."

Accordingly, the rejection is provided only because Hurst does not explicitly address the inherent feature. Chen is applied to make up this deficiency. The reason for combining the references of Hurst and Chen, as stated in the Office action made final, (Paper no. 23, filed 3 June 2003), and as repeated above, is

> "It would have been obvious to one of ordinary skill in the art at the time the invention was made to use a soft or hard ferromagnetic material to stabilize the magnetization of the edge regions of the sense layer in **Hurst** in a direction perpendicular to the easy axis of the sense layer and to use a hard ferromagnetic material as taught by **Chen** for the beneficial reasons indicated therein, because stabilized end regions improve the magnetic memory over one which does not have stabilized end regions, as taught in both **Hurst** and **Chen**."

Or alternatively as,

> "Alternatively, the prior art of **Chen**, as explained above, discloses each of the claimed features except for indicating that the keeper structure is in a U shape which encases the read/write conductors (i.e. the word line).
>
> "It would have been obvious for one of ordinary skill in the art, at the time of the invention to modify the structure of **Chen** to form the U-shape of **Hurst**, for the reasons indicated in **Hurst**, at least at col. 7, lines 6-15, to more effectively concentrate the magnetic field above the word line than could be obtained by a keeper structure not formed in a U shape and encasing the word line."

Moreover, it is noted, that there is no teaching away between the references of Chen and Hurst. Since both references are drawn to a MRAM, there exists a reasonable expectation of success in applying the teachings of Chen to Hurst.

This concludes the rebuttal of arguments presented under Issue III.

The Brief argues Issue IV beginning on p. 11 of the Brief stating,

> **"IV: Claim 42 is not obvious in view of Chen and Torok because Chen and Torok do not disclose or suggest the limitations of claim 34."**
>
> "Appellant respectfully, submits that claim 42 is not obvious in view of Chen and Torok because claim 42 depends from claim 34 and Chen and Torok do not disclose or suggest a magnetic memory cell having a keeper structure that provides a flux closure path between a pair of edge regions of a sense layer as claimed in claim 34. Instead, Chen discloses a pinning material 30 made up of physically distinct structures (Figs 5 and 6 of Chen) that cannot provide a flux closure path and Torok discloses GMR structures. (Torok, col. 3, lines 52-63). Furthermore, Chen and Torok do not disclose or suggest a keeper structure that applies magnetic fields using exchange coupling to the edge regions of a sense layer as claimed in claim 34."

As can be seen from the arguments previously presented, no new arguments are presented herein which have not been addressed already. Accordingly, all arguments have already been addressed.

This concludes the rebuttal of arguments presented under Issue III.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Erik Kielin, Ph.D.
February 19, 2004

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APPENDIX A

The Penguin Dictionary of

ELECTRONICS

Editor: Valerie Illingworth
for Market House Books

THIRD EDITION

PENGUIN BOOKS

PENGUIN BOOKS

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flux A measure of the strength of a field of force through a specified area. ➤electric flux; magnetic flux.

fluxmeter An instrument that measures changes in magnetic flux. The most usual type is the *Grassot fluxmeter,* which consists essentially of a moving-coil ➤galvanometer that is designed so that the restoring couple on the moving coil is negligibly small and electromagnetic damping is large. The galvanometer is used in conjunction with an exploring coil (➤flip-coil) of known area. A change in the magnetic flux cutting the exploring coil causes an induced current in the galvanometer coil and hence the latter is deflected. The angle of deflection is directly proportional to the change in magnetic flux through the exploring coil. The instrument is calibrated empirically using a magnetic flux standard.

flyback **1.** ➤time base. **2.** ➤sawtooth waveform.

fly by wire A method of controlling an aeroplane in flight. The flaps, rudder, and other control surfaces of the aeroplane are operated by motors. These motors are controlled by electrical signals that are created as a result of actions by the pilot. This kind of flight control system involves the use of computers to analyse the pilot's intentions and thus work out the right amount of movement of the control surfaces; the computers can override the pilot in situations that would endanger the aeroplane.

flying-spot scanner A device that produces a video signal from an object, such as a film, by scanning the object with a spot of light, which is then focused on a ➤photocell to produce corresponding electrical signals. The moving (or 'flying') spot of light is normally produced on the screen of a high-intensity cathode-ray tube used as a light source. Mechanical scanning of the object has also been employed, using a single point source of light, with a suitably perforated rotating disc between it and the object.

flywheel effect The continuation of oscillations in an ➤oscillator during the intervals between exciting pulses. It results from electrical inertia, which is analogous to mechanical inertia of a flywheel.

flywheel timebase ➤timebase.

f.m. (or **FM**) *Abbrev. for* frequency modulation.

FM receiver A ➤radio or ➤television receiver that detects frequency-modulated signals (➤frequency modulation).

FM synthesis ➤synthesis.

focusing The process or a method of making a beam of radiation or particles converge. In an electron-beam device, such as a ➤cathode-ray tube, two principal methods of focusing the beam are used.

In *electrostatic focusing* two or more electrodes at different potentials are used to focus the electron beam. The electrostatic fields set up between the electrodes cause the beam to converge; the focusing effect is controlled by varying the potential of one of the electrodes, termed the *focusing electrode.* The electrodes are usually cylindri-

sity at that point. It is assum ... iently small so as not to disturb the magnet

magnetic field strength *Syn.* magnetizing force. Symbol: $\boldsymbol{H}$; unit: ampere/metre. The strength of a magnetic field at a point in the direction of the line of force at that point. It is defined in a vacuum from the equation

$$\boldsymbol{B} = \mu_0 \boldsymbol{H}$$

where $\boldsymbol{B}$ is the ➤magnetic flux density and μ_0 is a constant, the ➤permeability of free space. ➤➤Ampere's law.

magnetic flux Symbol: Φ; unit: weber. The ➤flux through any area in the medium surrounding a magnet or current-carrying conductor, equal to the surface integral of the ➤magnetic flux density over the area. It is measured by the e.m.f. produced when a circuit linking the flux is removed from it. One weber of flux linking a circuit of one turn produces an e.m.f. of one volt in that circuit when the flux is reduced to zero.

magnetic flux density *Syn.* magnetic induction. Symbol: $\boldsymbol{B}$; unit: tesla (weber/metre^2). The fundamental force vector in magnetism; the magnetic analogue of the electric field $\boldsymbol{E}$. Both a magnet and a current-carrying coil exert forces on other coils or magnets. The magnetic flux density produced by such magnets or coils is a vector quantity and lines of flux can be drawn whose direction at any point is the direction of magnetic flux density. The value of $\boldsymbol{B}$ is given by the number of lines of flux per unit area and is expressed by the equation

$$\mathrm{d}\boldsymbol{F} = I(\mathrm{d}\boldsymbol{s} \times \boldsymbol{B})$$

where $\mathrm{d}\boldsymbol{F}$ is the force exerted due to $\boldsymbol{B}$ on an element of length $\mathrm{d}\boldsymbol{s}$ of wire carrying a current I. This defines the unit of magnetic flux density as that which exerts a force of one newton on a wire of length one metre carrying a current of one ampere.

magnetic focusing *Syn. for* electromagnetic focusing. ➤focusing.

magnetic head ➤magnetic recording.

magnetic hysteresis A phenomenon observed in ferromagnetic materials below the Curie point (➤ferromagnetism) where the ➤magnetization of the material varies nonlinearly with the ➤magnetic field strength and also lags behind it. The magnetic ➤susceptibility of such materials is large and positive, a large value of magnetization being produced for comparatively small fields. A characteristic plot of either magnetization, $\boldsymbol{M}$, or ➤magnetic flux density, $\boldsymbol{B}$, against magnetic field strength, $\boldsymbol{H}$, demonstrates the hysteresis effect and is termed a *hysteresis loop* (see diagram). If an initially unmagnetized sample of iron is subjected to an increasing magnetic field the magnetization follows the curve shown by the dotted line OAS. This is known as the *magnetization curve.* If the specimen is then subjected to a complete magnetizing cycle with magnetic field varying symmetrically between $+H$ and $-H$ the curve shown by the solid line is followed.

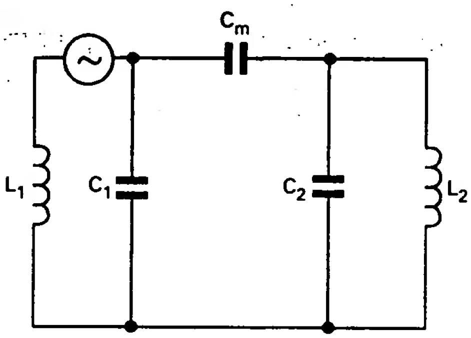
APPENDIX B

counter/frequency meter An instrument that can be used as a counter or frequency meter by counting the number of events or periods occurring in a given time. It contains a frequency standard, usually a ➤piezoelectric oscillator. The time between events may also be counted by comparing the number of standard pulses occurring in the same time as a given number of cycles of the frequency standard.

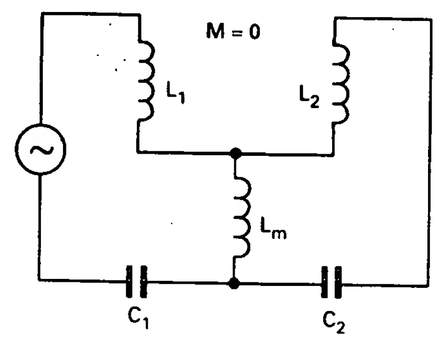
counter lag time ➤counter.

count rate ➤counter.

coupling The interaction between two circuits so that energy is transferred from one to the other. In *common-impedance coupling* there is an impedance common to both circuits (Figs. *a, b*).

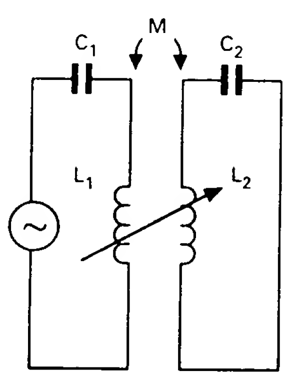


a Capacitive **coupling**



b Inductive **coupling**

The impedance may be a capacitance (*capacitive coupling*), a capacitance and a resistance (*resistance-capacitance coupling*), an inductance (*inductive coupling*), or a resistance (➤direct coupling). The impedance may be a part of each circuit or connected between the circuits. In *mutual-inductance coupling* the circuits are coupled by the mutual inductance, *M*, between the coils L_1 and L_2 (Fig. *c*). The coils used are often those of a transformer. The use of two separate coils between amplifier stages rather than a transformer is termed *choke coupling*. *Mixed coupling* is a combination of mutual-inductance coupling and common-impedance coupling.



c Mutual-inductance **coupling**